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Andrea Beltratti, Matteo Benetton
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Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801
www.cepr.org

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THE ROLE OF PREPAYMENT PENALTIES IN MORTGAGE LOANS[†]

Abstract

We study the effect of mortgage prepayment penalties on borrowers' prepayments and delinquencies by exploiting a 2007 reform in Italy that reduced penalties on outstanding mortgages and banned penalties on newly-issued mortgages. Using a unique dataset of mortgages issued by a large Italian lender before and after the reform, we provide evidence that: 1) before the reform, mortgages issued to riskier borrowers included larger penalties; 2) higher prepayment penalties decreased borrowers' prepayments; 3) higher prepayment penalties did not affect borrowers' delinquencies; and 4) prepayment penalties indirectly affected prepayments and delinquencies through borrowers' mortgage selection at origination, especially for riskier borrowers.

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Andrea Beltratti andrea.beltratti@unibocconi.it
Università Bocconi

Matteo Benetton m.benetton1@lse.ac.uk
London School of Economics

Alessandro Gavazza a.gavazza@lse.ac.uk
London School of Economics and CEPR

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1 Introduction

For most households, housing represents their major asset and a mortgage represents their largest liability. Hence, the choice of a mortgage contract is one of households' most important financial decisions, and its management has important aggregate implications (Mian, Rao, and Sufi, 2013). Mortgages vary along several important characteristics (interest rate, maturity, etc.), and in this paper we focus on the role of one key contractual feature: the prepayment penalty.

Different incentives spur borrowers to prepay their mortgages: some depend on borrowers' characteristics, such as positive income shocks, and some depend on mortgage market characteristics, such as changes in interest rates. Specifically, when interest rates fall, borrowers may choose to refinance their higher interest rate mortgages with lower interest rate ones. Moreover, the decline in interest rates traditionally increases house sales and house prices, thereby magnifying the benefits of mortgage refinancing. Hence, when interest rates fall, mortgages' cash flows may be lower than expected, thereby generating a risk for lenders. Overall, prepayment penalties allow lenders to reduce these risks because they reduce borrowers' incentives to prepay their mortgages. Therefore, prior to the recent financial crisis, most mortgages included these penalties—especially those offered to riskier borrowers—perhaps making them more affordable through a lower interest rate (Mayer, Piskorski, and Tchisty, 2013). However, the crisis spurred a heated debate over the usefulness and fairness of prepayment penalties. One argument against them is that they raise the cost of repaying a loan through a refinancing or sale. Hence, borrowers unable to pay their mortgages may find prepayment expensive, thereby increasing delinquencies if these borrowers receive negative shocks in the future.¹ Moreover, because a prepayment penalty raises the cost of refinancing with other lenders, it tends to reduce competition at the refinancing stage, potentially increasing “predatory” practices: the initial lender could offer refinancing on terms that ultimately harm borrowers (Bond, Musto, and Yilmaz, 2009). As a result of this debate,

¹We use the terms default and delinquency interchangeably, as our data do not allow us to distinguish between them.

legislators in many countries imposed new rules restricting the use of these penalties; Title XIV of the Dodd-Frank Act in the United States is one example.²

This paper exploits a 2007 reform in Italy that banned penalties on newly-issued mortgages and reduced them on outstanding ones.³ This reform provides a quasi-natural experiment to investigate households' decision to prepay and, more generally, how prepayment penalties affect the equilibrium in mortgage markets. To this goal, we collect a unique dataset that reports all mortgages issued by a large Italian lender in 2005 and 2009, along with their performance until 2012.

The reform triggered variations that allow us to disentangle the effects of penalties on households' prepayment behavior and on households' mortgage choice. Our empirical analysis proceeds in three steps, establishing several results. In the first step, we consider only mortgages issued before the reform, and we show that fixed-rate mortgages (FRMs) always include penalties, whereas most adjustable-rate mortgages (ARMs) do not, with the exception of the riskiest ARMs. Moreover, penalties on more-risky FRMs are larger than those on less-risky ones.

These initial findings motivate our next analyses. Thus, in the second step, we focus on mortgages issued in 2005 and document that prepayment is substantially higher for mortgages with lower penalties. However, this correlation lumps together two effects: 1) penalties directly affect borrowers' cost-benefit analysis when deciding to prepay (or to default); and 2) at the time of contracting, borrowers who expect that they are less likely to prepay (or to default) on their mortgage could select higher-penalty mortgages, with perhaps other, more-favorable terms. To further identify the causal effect of penalties on prepayments and, thus, disentangle these two effects, we exploit the exogenous variation in penalties due exclusively to the reform. We estimate that a one-percentage-point increase in penalties decreases

²Title XIV of the Dodd-Frank Act (Mortgage Reform and Anti-Predatory Lending Act) prohibits prepayment penalties on all adjustable-rate mortgages and certain high-priced fixed-rate mortgages. On all other mortgages, the amount of the penalty in the first, second, and third year after origination is limited to three, two, and one percent, respectively, of the outstanding loan balance, and the penalty is prohibited three years after origination. The Appendix describes the current regulation of penalties in selected countries.

³Italy has one the lowest mortgage debt to GDP ratios among developed countries. However the ratio of outstanding mortgage to GDP grew from seven percent in 1997 to more than 20 percent in 2010.

prepayment by approximately 20 percent—a sizable effect. Moreover, we find no statistically significant evidence that penalties have a direct effect on delinquencies (i.e., missed payments).

In the third step of our empirical analysis, we seek to understand the effect of penalties on borrowers' choice of mortgage contract, with a special focus on their choice between FRMs and ARMs, using data from mortgages issued in 2005 and 2009. Aggregate shocks may confound the interpretation of these comparisons over time: our lender merged with another bank in 2007, and the financial crisis and the European sovereign-debt crisis affected mortgage markets as well.⁴ To minimize these potential concerns, we perform a comparison between FRMs and ARMs within three groups of mortgages: 1) those issued in 2005, before the reform that reduced penalties on them; 2) those issued in 2005, after the reform that reduced penalties on them; and 3) those issued in 2009. We argue that, by reducing penalties, the reform made mortgages in the last two groups relatively similar in terms of their incentives to prepay and to default, and by comparing them within the same time-period, any observed difference between them should be suggestive of borrowers' selection at the time of contracting. We document that the differences in prepayment and delinquency rates between FRMs and ARMs have increased by 36 and 55 percent, respectively, when we compare mortgages issued in 2009 with mortgages issued in 2005 but after the reform reduced penalties on them. Overall, this last step of our analysis describes a consistent pattern that borrowers' selection of FRMs versus ARMs is substantially different after the reform, most notably for riskier borrowers—i.e., borrowers who faced greater overall uncertainty and who were more likely to be subject to penalties before the reform.⁵

⁴However, it is important to note that the European sovereign-debt crisis started in late 2009 in Greece and spread to other European countries in 2010 and 2011. The Italian sovereign bond market did not receive major shocks until the summer of 2011: the 10-year bond spread over German bonds was quite stable at a value below 100 basis points until May 2010, when it rose to around 150 basis points; in July 2011 it quickly climbed, reaching over 500 basis points at the end of 2011.

⁵Unfortunately, our data do not report detailed demographic characteristics of borrowers and the bank merged with another bank in 2007, changing its borrowers' credit-scoring model between 2005 and 2009. These data limitations do not allow us to analyze the extent to which the lender adjusted its interest rates after the reform to compensate for the loss of these prepayment fees. Evidence from other markets for household financial products indicate that lenders may be slow to adjust to these reforms: for example, Agarwal, Chomsisengphet, Mahoney, and Stroebe (2015) report that lenders did not adjust interest rates immediately after the Credit CARD Act of 2009 reduced credit card fees.

The paper proceeds as follows. Section 2 reviews the literature, highlighting our contributions. Section 3 provides some background information on mortgage markets in Italy and explains in detail the provisions of the 2007 Reform. Section 4 presents the data. Section 5 presents our empirical analysis, and Section 6 concludes. The Appendix describes the current regulation of penalties in selected countries.

2 Related Literature

Our paper contributes to several strands of the literature. The first one is the literature that analyzes how prepayment penalties affect mortgage terms, with a special focus on the interest rate (Dunn and Spatt, 1985; Mayer, Piskorski, and Tchisty, 2013; Rose, 2012). A few papers investigate how penalties affect borrowers' prepayments and delinquencies, finding a negative correlation between penalties and both prepayments and delinquencies (see, among others, Rose, 2013). However, the interpretation of these correlations may not be straightforward; for example, borrowers who know that they are less likely to prepay may prefer mortgages with penalties since they are less likely to pay them. Hence, our main contribution to this strand of literature is our use of a novel (and, in our view, more compelling) identification strategy that exploits a policy change to the level of prepayment penalties to infer their causal effect on borrowers' behavior. A more-precise identification seems quite valuable, as the option to prepay makes mortgages different from other loans and, as our data confirm, this option is quantitatively more relevant than the default option (Beckett, 1988; Deng, Quigley, and Order, 2000). Moreover, understanding the determinants of prepayment risk is important from the point of view of financial market investors and intermediaries. Prepayments play a key role in the valuation of mortgage-backed securities (Beckett, 1988; Campbell, 2013). Gabaix, Krishnamurthy, and Vigneron (2007) show that prepayment risk is not fully diversified in equilibrium, and, thus, it is priced in the MBS market. Boyarchenko, Fuster, and Lucca (2014) propose that prepayment risk is a driver of MBS spreads and can explain links between the spread and contractual characteristics of the securities. Perli and Sack (2003) notice that the combination of prepayment risk and

low interest rates may magnify the impact of MBS holders' hedging strategies on long-term interest rates. Malkhozov, Mueller, Vedolin, and Venter (2014) study the negative convexity of MBS due to the prepayment option and document its relation to excess bond returns and their volatility. In many countries, including Italy, securitization has not been an important source of funding for banks, but prepayment introduces a potential mismatch between the maturities of banks' assets and liabilities. Thus, banks may want to hedge their interest rate exposure and fully match assets with liabilities, but they cannot entirely do so to the extent that they cannot perfectly predict mortgages' future cash flows.

Third, several papers study households' choice between FRMs and ARMs, with a special focus on the role of the interest rate differential (Brueckner and Follain, 1988; Campbell and Cocco, 2003; Koijen, Van Hemert, and Van Nieuwerburgh, 2009). Our paper contributes to this academic debate by focusing on the effects of one contractual feature that has been at center of the policy debate: the prepayment penalty. By affecting prepayments and households' choice between FRMs and ARMs, penalties also affect the transmission of monetary policy into consumption (Calza, Monacelli, and Stracca, 2013).

Fourth, by showing how penalties affect the relative riskiness of different contracts' pools of borrowers, our paper complements several recent contributions that analyze households' defaults on their mortgages (Deng, Quigley, and Order, 2000; Mayer, Pence, and Sherlund, 2009; Demyanyk and Van Hemert, 2011), car loans (Adams, Einav, and Levin, 2009; Einav, Jenkins, and Levin, 2012; Assunção, Benmelech, and Silva, 2014) and credit cards (Gross and Souleles, 2002).

Finally, our paper contributes to the current debate on the design of mortgage markets by establishing novel micro-evidence on the effects of an important policy using data from a different country, Italy. Mortgage markets vary greatly across countries, and international comparisons can help to devise optimal regulation (Campbell, 2013). More broadly, many countries have recently enacted reforms and introduced new regulations in markets for consumer financial products, and our paper complements a few recent contributions that analyze the effects of these reforms. For example, Assunção, Benmelech, and Silva (2014) study the effects of a 2004 Brazilian reform that simplified the sale of repossessed cars on car loans;

and Agarwal, Chomsisengphet, Mahoney, and Stroebel (2015) analyze how regulatory limits on credit card fees affect borrowing costs.

3 Institutional Background

Among developed countries, Italy has one of the highest homeownership rates, as well as one of the lowest mortgage debt-to-GDP ratios (Campbell, 2013). However, in recent years, mortgage markets developed rapidly, as the gap between house prices and available income increased, and foreign lenders entered the Italian market. For example, between 2004 and 2007, Italian banks issued mortgages for an annual total value of 60 billion euros, which is unprecedented for the Italian market (Bonaccorsi di Patti and Felici, 2008). We now illustrate some key characteristics of the Italian mortgage market and then provide a detailed description of the provisions of the 2007 Reform.

3.1 Mortgage Markets in Italy

Like several other countries, between 1998 and 2007, Italy experienced a prolonged increase in house prices, as well as an increase in banks' exposure to the housing market. By June 2012, housing-related loans accounted for 50 percent of private-sector lending, with mortgages to households accounting for more than 20 percent (Gobbi and Zollino, 2012).

Historically low interest rates, along with a favorable housing cycle and increasing competition between lenders, expanded the availability of mortgages to households. More specifically, the expanding supply of mortgages with maturity above 30 years, high loan-to-value and alternative mortgages (i.e., high ratio between first payments and income) made mortgages accessible to households that were previously excluded from the market (i.e., young families and immigrants). The financial crisis halted the expansion of the mortgage market, reducing both demand, as unemployment rose and households' income declined, and supply, as stricter balance sheet requirements and worse quality of applicants tightened most banks' lending policies. From 2004 to 2007, banks and other lenders issued 266,000 mortgages annually, whereas between 2008 and 2011, they issued 208,000 contracts, a 22-percent decline

(Felici, Manzoli, and Pico, 2012).⁶

Traditionally, ARMs represented the most common mortgages on the Italian market, accounting for approximately 80 percent of new mortgages issued from 1999 to 2005 (Bonaccorsi di Patti and Felici, 2008).⁷ However, in the period 2007-2009, the share of new ARMs declined to about 30 percent of all mortgages issued, as the difference between the fixed and the variable rates declined substantially, while the short-term Euribor rate increased. Hence, the share of FRMs increased from six to 67 percent between 2005 and 2008. However, by 2011, the ARMs share reverted to about 80 percent, as short-term interest rates declined.

The average mortgage size increased from 134,000 euros in 2004-2007 to 145,000 euros in 2008-2011, broadly in line with the increase in the consumer price index over the same period, with larger increases in provinces with higher house-price growth. This increase in size is attributable to the higher incidence of mortgages above 150 thousands euros, issued mainly to high-income borrowers (Felici, Manzoli, and Pico, 2012). Loan-to-values declined from 68.7 percent in 2006 to 61.1 percent in 2011.

The focus of our empirical analysis is on the role of prepayment penalties. The main Italian economic newspaper, *Il Sole 24 Ore*, reported that, in 2006, the average prepayment penalty was between one and two percent of the mortgage amount for ARMs, and between two and three percent for FRMs, but some penalties were as high as eight percent (*Il Sole 24 Ore*, February 2, 2007). Hence, for a mortgage of the average size of 134,000 euros, average penalties were between 1,340 and 2,680 euros for ARMs and between 2,680 and 4,020 euros for FRMs, with an extra cost of almost 10,000 euros for the mortgages with the highest penalties. Most banks attach higher prepayment penalties to ARMs than to FRMs, and penalties displayed only small differences across banks (*Il Sole 24 Ore*, October 21, 2006).

Prepayment of mortgages is lower in Italy than in other developed countries, with about

⁶Bank regulation and supervision through the Basel accords also changed banks' incentives to supply mortgages after 2008. More specifically, the Basel II accords, implemented in 2008 in several countries, including Italy, specified banks' minimum capital requirement based on risk-weighted assets, thereby including mortgages. The Basel I accords, banks' regulatory framework before 2008, did not include such provisions. Thus, the regulatory change also provided banks with stronger incentives to invest in the improvement in their credit-scoring systems (Jankowitsch, Pichler, and Schwaiger, 2007).

⁷ARMs are defined as mortgages with a variable rate or fixed up to one year, while FRMs are mortgages with a rate fixed for more than ten years.

six percent of borrowers refinancing their mortgages in 2007 (*Il Sole 24 Ore*, March 6, 2007), but it gradually increased over time. Some observers argue that many prepayments are due to events such as bequests and retirements, rather than to changes in interest rates and other contractual conditions (*Il Sole 24 Ore*, April 19, 2007).

3.2 The 2007 Reform

The 2007 reform was part of liberalization measures involving different sectors of the Italian economy. Article 7 of the law is our main focus, as it regulates prepayment penalties for residential mortgages.⁸

The reform was the result of an increasing demand from consumers' associations for better protection of consumers' choice rights in a growing and differentiated mortgage market. Prepayment penalties are often labeled as “predatory” since lenders can use them to lock borrowers into contracts, which could be profitable for the former and costly for the latter (Bond, Musto, and Yilmaz, 2009; Rose, 2013). For several years, consumers' associations argued against the excessive prepayment cost due to penalties and the difficulties of transferring mortgages across banks (*Il Sole 24 Ore*, May 2, 2007). These issues became more relevant in 2006, as the increase in the Euribor rate made outstanding ARMs more expensive, thus increasing the incentive to prepay or refinance them.

In our empirical analysis, we will investigate two effects of Article 7. First, the reform affected all 3.5 million outstanding residential mortgage contracts. The law provided that Italian banks and consumers' associations had to agree on limits to prepayment penalties applicable to mortgages issued before 2007. For existing ARMs, maximum penalties were set to 0.5 percent, 0.2 percent in the third-from-last year, and zero in the last two years of amortization. For existing FRMs, maximum penalties were set to 1.90 in the first half of the amortization period, 1.50 percent in the second half, 0.2 percent in the third-from-last year, and zero in the last two years of amortization. These reductions were exogenous and unexpected for borrowers who took their mortgages before the reform. Thus, in Section 5.2, we exploit this provision, along with data on mortgages issued before the reform, to analyze

⁸“Decreto Legge” n.7 (January 31, 2007) converted into law n. 40 (April 2, 2007).

the effect of prepayment penalties on prepayments as well as on delinquencies. Second, the reform abolished prepayment penalties on all new mortgages issued for purchasing households' main residence. Thus, in Section 5.3, we exploit this provision, along with data on mortgages issued before and after the reform, to analyze the effect of prepayment penalties on households' choice between FRMs and ARMs.

4 Data

We obtain proprietary data on all mortgages that a large Italian bank issued in 2005 and 2009. The bank merged with another bank in 2007, and the 2005 sample is from one of the (then separate) lenders, whereas the 2009 sample is from the merged entity.

We study mortgages issued with the purpose of buying households' primary residence, which represent more than 90 percent of the mortgages in our sample. The literature identifies two main categories of mortgages: FRMs and ARMs (Campbell, 2006; Koijen, Van Hemert, and Van Nieuwerburgh, 2009; Badarinza, Campbell, and Ramadorai, 2014). Therefore, we focus our analysis on these two types and drop mortgages with interest rates classified as mixed (approximately nine percent of the mortgages in our original sample). We further exclude mortgages issued to bank employees, which account for four percent of the sample composed of ARMs and FRMs. Our final sample has 40,025 mortgages, 20,434 issued in 2005 and 19,591 issued in 2009.

Our database contains detailed information on contract terms and mortgages performance until December 2012, whereas detailed information on the collateral and on borrowers' characteristics is available only for mortgages issued in 2009. We observe the interest rate applicable over the life of the loan (fixed for FRMs, spread over Euribor for ARMs); the amount of the loan; the loan-to-value ratio; the date of issuance; the maturity; and the amount of prepayment penalties. The database further includes information on the performance of the mortgage, such as any amount prepaid and all delinquencies throughout the life of the mortgage until 2012. For mortgages issued in 2012, we observe some borrowers' characteristics at origination, such as age, gender, personal and family income, occupation,

and number of people in the household.

We complement our original dataset with additional aggregate time-varying variables that seek to capture incentives to prepay or to default during the contract period. We use the ARM refinancing rate at time t , equal to the three-month Euribor plus the posted spread that the lender charges on a 20-year ARM, to proxy for the incentives to refinance the current mortgage with an ARM; and the 20-year FRM refinancing rate at time t , equal to the Eurirs plus the posted spread that the lender charges on a 20-year FRM, to capture the incentives to refinance with a FRM. While the entire yield curve should matter for refinancing incentives across different maturities, these short-term and long-term rates are those of the most popular mortgages in the Italian market, and the evidence reported in Badarinza, Campbell, and Ramadorai (2014) indicate that these rates on ARMs and FRMs capture well refinancing incentives.⁹ Moreover, we further include the annual growth rate of the GDP to capture aggregate macroeconomic conditions.

In Table 1, we compare mortgage characteristics and performances by year of issuance and interest-rate type. Panel A compares mortgages by year of issuance and shows that mortgages issued in 2005 have higher interest rates and loan-to-values, but lower sizes and shorter maturities, than those issued in 2009. Prepayment penalties apply only to the 2005 cohort and the average penalty is about one percent. With respect to ex-post performances, we observe more prepayments and delinquencies for 2005 than for 2009 mortgages. These differences are due partly to the fact that we observe 2005 mortgages for a longer period of time, but in the case of prepayment, they persist if we consider them only until four years after the issuance. Table 1 also shows that 18 percent of mortgages are prepaid, whereas only three percent are delinquent, confirming that prepayments are quantitatively more relevant

⁹Koijen, Van Hemert, and Van Nieuwerburgh (2009) suggest that the long-term bond risk premium is the main determinant of mortgage choice, and they find support for this hypothesis using U.S. data. Instead, Campbell and Cocco (2003) and Campbell (2013) argue that the spread between the FRM rate and the current ARM rate may be the most relevant variable for determining mortgage choice since borrowing-constrained households care about current interest costs and are likely to choose ARMs in order to reduce those costs. Badarinza, Campbell, and Ramadorai (2014) use international data outside the U.S. to study the main determinant of mortgage choices: their results generally support the hypothesis that the spread between the FRM rate and the current ARM rate is the proximate driver of household mortgage choice, whereas they find little support for the hypothesis that the long-term bond risk premium helps determine the ARM share.

than delinquencies. The difference between the FRM and ARM refinancing rates suggest that refinancing FRMs with ARMs could substantially lower at least borrowers' initial monthly payments after the refinancing.

Panel B of Table 1 compares fixed-rate and adjustable-rate mortgages. FRMs have a significantly higher interest rate and a lower amount and collateral. The average interest rate difference between FRMs and ARMs is around two percent. At origination, ARMs appear more risky than FRMs: ARMs have, on average, higher loan-to-values and longer maturities than FRMs. FRMs and ARMs are also significantly different when we focus on prepayment penalties. Almost all FRMs issued in 2005 feature a prepayment penalty, and the average penalty is 2.6 percent; whereas only 20 percent of ARMs issued in 2005 feature such a penalty, and the average penalty is 0.4 percent. The comparison of ex-post performances confirms the differences that we documented at origination. ARMs are more risky: they are more likely to be delinquent than FRMs—four percent of ARMs are delinquent versus one percent of FRMs—and they are more likely to be prepaid than FRMs—21 percent of ARMs are prepaid versus 15 percent of FRMs.¹⁰

Overall, our dataset is ideally suited to investigating how prepayment penalties affect borrowers' behavior on their outstanding mortgages and to providing insights on how penalties affect borrowers' mortgage selection. Even with all these advantages, however, the data pose some challenges. First, they do not report detailed borrowers' characteristics. In particular, they do not report information on borrowers' assets/liabilities and their evolution over time. Similarly, they report income at origination only for mortgages issued in 2009, and there is no information on its evolution. The absence of detailed demographics, along with the fact that the lender changed its credit-scoring model between 2005 and 2009, implies that our empirical analysis cannot determine the extent to which the lender adjusted its interest rates after the reform to compensate for the loss of prepayment penalties. Second, the data do not report any information on the reasons for prepayments and delinquencies. For example, they do not report whether the prepayment is due to a refinancing with a

¹⁰The 20-year and the three-month interest rates differ between FRMs and ARMs because of their different share over time.

Table 1: Summary statistics

PANEL A: MORTGAGES BY YEAR OF ISSUANCE					
	2005		2009		DIFFERENCE
	MEAN	S.D.	MEAN	S.D.	
FRM SHARE (%)	29.00	45.00	60.00	49.00	-31.00***
INTEREST RATE (%)	3.92	0.71	3.89	1.47	0.02*
AMOUNT (000 EUROS)	103.06	76.43	116.42	83.95	-13.36***
COLLATERAL (000 EUROS)	221.97	650.24	246.73	1550.00	-24.76*
LOAN-TO-VALUE (%)	55.74	22.31	55.17	22.55	0.57*
MATURITY (YEARS)	19.29	6.21	20.23	7.39	-0.94***
PENALTY DUMMY (%)	44.00	50.00	0.00	0.00	44.00***
PENALTY AMOUNT (%)	1.04	1.33	0.00	0.00	1.04***
DELINQUENCY (%)	5.00	21.00	1.00	9.00	4.00***
DELINQUENCY - 4 YEARS (%)	1.00	10.00	1.00	9.00	0.00***
PREPAYMENT (%)	25.00	44.00	10.00	30.00	15.00***
PREPAYMENT - 4 YEARS (%)	13.00	34.00	10.00	30.00	3.00***
ARM REFI RATE (%)	4.05	0.04	3.00	0.03	1.04***
FRM REFI RATE (%)	5.56	0.02	5.29	0.02	0.26***

PANEL B: MORTGAGES BY INTEREST RATE TYPE					
	FRM		ARM		DIFFERENCE
	MEAN	S.D.	MEAN	S.D.	
INTEREST RATE (%)	4.99	0.43	3.05	0.74	1.94***
AMOUNT (000 EUROS)	93.45	59.14	122.34	91.99	-28.89***
COLLATERAL (000 EUROS)	210.40	329.49	252.76	1550.00	-42.36***
LOAN-TO-VALUE (%)	51.52	22.59	58.58	21.80	-7.06***
MATURITY (YEARS)	18.57	6.98	20.69	6.56	-2.12***
PENALTY DUMMY ^a (%)	98.00	14.00	21.00	41.00	77.00***
PENALTY AMOUNT ^a (%)	2.60	0.74	0.40	0.92	2.20***
DELINQUENCY (%)	1.00	12.00	4.00	19.00	-3.00***
DELINQUENCY - 4 YEARS (%)	1.00	8.00	1.00	11.00	-0.00***
PREPAYMENT (%)	15.00	35.00	21.00	40.00	-6.00***
PREPAYMENT - 4 YEARS (%)	10.00	30.00	13.00	34.00	-3.00***
ARM REFI RATE (%)	3.36	0.50	3.68	0.50	-0.32***
FRM REFI RATE (%)	5.38	0.13	5.47	0.13	-0.08***

Notes: Penalty dummy is a binary variable taking value one when the mortgage has a positive prepayment penalty and zero otherwise. Penalty amount is the actual amount of the penalty. Delinquency is a dummy variable taking value one if the mortgage has a missed payment in any year in the sample. Prepayment is a dummy variable equal to one if the mortgage is repaid in full before maturity and the remaining amount at the time of the last payment is positive. t-statistics in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

^aCalculated only on mortgages issued in 2005.

newly-issued mortgage, to the sale of the house, or to a bequest that allows borrowers to fully repay the mortgage. Third, as mentioned in footnote 1, the data do not allow us to distinguish between delinquencies (i.e., missed and late payments) and defaults. Finally, we do not have any information on the market value of each property over time, which would allow us to compute borrowers' equity and, thus, to evaluate the extent to which borrowers' defaults are strategic; however, mortgages are recourse loans according to Italian law, which mitigates concerns about the role of strategic defaults.

5 Empirical Analysis

Our empirical analysis proceeds in three main steps. First, we use only mortgages issued in 2005 to show that riskier mortgages were more likely to include prepayment penalties. Second, and central to our analysis, to study the effect of penalties on households' prepayment behavior, we use mortgages issued in 2005 and exploit the exogenous variation in penalties due to the 2007 reform. Third, we compare mortgages issued in 2005 and 2009 and provide suggestive evidence that the abolition of penalties affected households' mortgage choice between ARMs and FRMs, most notably inducing riskier borrowers to disproportionately choose FRMs.

5.1 Which Mortgages Include Prepayment Penalties?

We compare mortgages with and without penalties in panel A of Table 2, looking at contract characteristics and ex-post performances. Mortgages with penalties have, on average, higher interest rates, smaller amounts, lower loan-to-value and shorter maturities. A comparison of ex-post performances indicates that mortgages with penalties are less likely to be prepaid and less likely to default.

Since 98 percent of FRMs include prepayment penalties, whereas only 20 percent of ARMs include them, panel B of Table 2 explores whether the previous differences between mortgages with and without penalties persist once we control for how the interest rate is set. Panel B indicates that ARMs with penalties have higher interest rates, higher loan-to-value

and longer maturities than ARMs without penalties. Hence, ARMs with penalties appear more risky than ARMs without penalties at origination. Indeed, ARMs with penalties are more likely to default than ARMs without penalties. Moreover, ARMs with penalties are less likely to be repaid than those without penalties, suggesting that penalties affect borrowers' prepayment behavior.

Since almost all FRMs include penalties, we compare FRMs with higher penalties to those with relatively lower penalties. Overall, for most characteristics, the differences between FRMs with larger penalties and FRMs with smaller penalties are similar to the differences between ARMs with penalties and ARMs without penalties. The collateral value (i.e., the price of the house) represents the most noticeable discrepancy in this comparison.

Overall, the empirical patterns that emerge from Table 2 motivate the analyses of the next two sections. Specifically, the table suggests a thorough analysis of the direct effect of penalties on prepayment behavior, and, thus, section 5.2 exploits the 2007 revision of penalties on mortgages issued in 2005 to identify this effect. The table further suggests that penalties were more likely to apply to higher-risk borrowers and to FRMs. Thus, section 5.3 compares the difference between FRMs issued in 2005 and in 2009 to the difference between ARMs issued in 2005 and in 2009 to seek to understand whether the abolition of penalties affected borrowers' choice among mortgage contracts.

5.2 Prepayment Penalties and Borrowers' Behavior

In this section, we identify the effect of prepayment penalties on borrowers' behavior using mortgages issued in 2005 to exploit the exogenous variation in penalties due to the 2007 reform.

Specifically, following Deng, Quigley, and Order (2000), who show that the simultaneity of the prepayment and delinquency options are important to explain borrowers' behavior, we specify an empirical model of borrowers' repayment behavior that includes two different outcomes: anticipated repayment (i.e., prepayment) and no repayment (i.e., delinquency). For this purpose, we employ stratified hazard models with competing risks, which allow us

Table 2: Prepayment penalties

PANEL A: ALL MORTGAGES					
	WITH PENALTY		WITHOUT PENALTY		DIFFERENCE
	MEAN	ST. DEV.	MEAN	ST. DEV.	
INTEREST RATE (%)	4.53	0.63	3.45	0.29	1.08***
AMOUNT (000 EUROS)	86.95	57.58	115.49	86.24	-28.54***
COLLATERAL (000 EUROS)	227.39	948.91	217.79	232.71	9.60
LOAN-TO-VALUE (%)	52.64	23.13	58.13	21.35	-5.49***
MATURITY (YEARS)	18.07	6.10	20.23	6.13	-2.16***
DELINQUENCY (%)	4.00	20.00	5.00	22.00	-1.00***
PREPAYMENT (%)	21.00	41.00	28.00	45.00	-7.00***

PANEL B: MORTGAGES BY INTEREST RATE TYPE						
	FRM		DIFFERENCE	ARM		DIFFERENCE
	HIGH	LOW		WITH	WITHOUT	
	PENALTY	PENALTY	PENALTY	PENALTY		
INTEREST RATE (%)	4.87	4.86	0.02	3.86	3.43	0.43***
AMOUNT (000 EUROS)	74.76	89.19	-14.44***	104.30	115.46	-11.16***
COLLATERAL (000 EUROS)	178.87	267.69	-88.81***	283.14	215.37	67.78***
LOAN-TO-VALUE (%)	48.80	44.67	4.12***	62.63	58.16	4.47***
MATURITY (YEARS)	16.31	17.58	-1.28***	20.99	20.22	0.76***
DELINQUENCY (%)	0.00	0.00	0.00	7.00	5.00	2.00***
PREPAYMENT (%)	18.00	27.00	-9.00***	23.00	29.00	-6.00***

Notes: FRMs with high (low) penalty are those whose penalty is above (below) 3 percent. About 70 percent of FRMs have a high penalty. t statistics in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

to capture borrowers' repayment behavior in a flexible way and to account for the censoring of the data after December 2012.

We start with a non-parametric graphical analysis. We have two separate events of interest (i.e., $K = 2$): prepayment ($k = 1$) and delinquency ($k = 2$). We calculate the instantaneous hazard $h_k(s)$ of an event k at s , given that the borrower has not fully repaid the mortgage and has not defaulted.¹¹ Hence, $h(s) = \sum_{k=1}^K h_k(s)$ gives the overall hazard rate, given the K possible "failure" events, and $\frac{h_k(s)}{h(s)}$ gives the probability of event k once a failure occurs. From the event-specific hazard $h_k(s)$, we obtain the cumulative incidence function $CIF_k(s)$, the probability of event k happening before (or up to) s , as

$$CIF_k(s) = \int_0^s h_k(x)S(x)dx,$$

where $S(x)$ is the overall survival function.¹² We can obtain a non-parametric estimate of the cumulative incidence function as:

$$\widehat{CIF}_k(s) = \sum_{j:s_j \leq s} \frac{d_{kj}}{n_j} \widehat{S}(s_{j-1}),$$

where $\widehat{S}(\cdot)$ is the Kaplan-Meier estimate of surviving for all failures; d_{kj} is the number of failures from cause k at s_j ; and n_j is the number at risk of failing from any cause at s_j . In our case, we specify s as the fraction of the mortgage repaid, rather than time, to take into account mortgages of different maturities. Hence, s ranges from 0 at origination to 1 when the borrower fully repays it.

Figure 1 plots these non-parametric estimates of the cumulative incidence functions of prepayments (top panel) and delinquencies (bottom panel), distinguishing between ARMs (solid line) and FRMs (dashed line). The panels display interesting patterns. First, the cumulative incidence of prepayments and delinquencies are higher for ARMs than for FRMs,

¹¹When we compute the cause-specific hazard for prepayment $h_1(t)$, failure due to default is treated as right-censored.

¹²Let $H_k(x)$ be the cause-specific cumulative hazard for cause k . Then, $H(x) = \sum_{k=1}^K H_k(x)$ is the overall cumulative hazard, and $S(x) = \exp(-H(x))$ gives the relationship between the overall survival and the overall cumulative hazard.

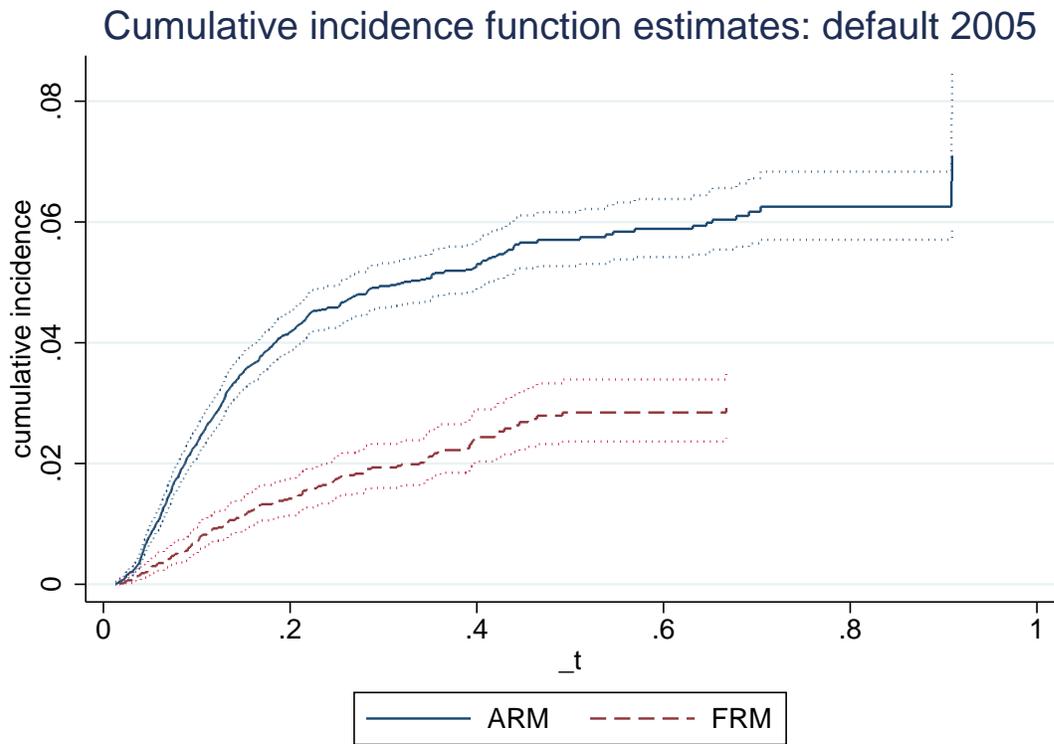
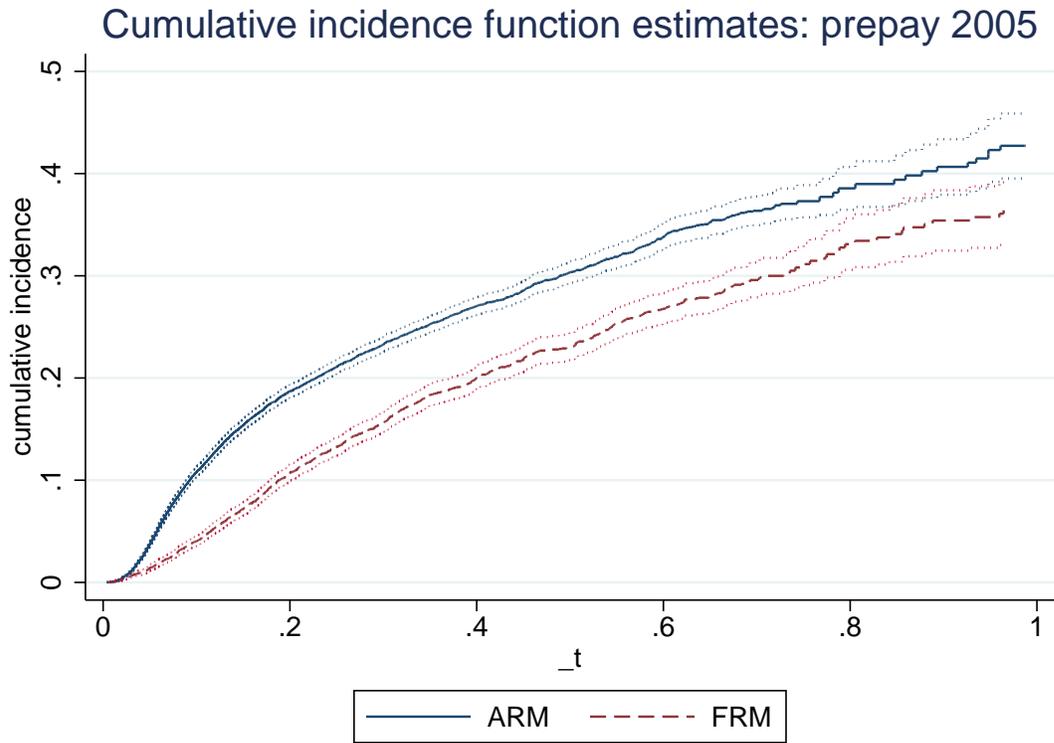


Figure 1: The top panel displays the cumulative incidence of prepayments, the bottom panel displays the cumulative incidence of delinquencies of mortgages issued in 2005.

confirming that ARMs are riskier than FRMs. Second, the plot of prepayments' cumulative incidence shows that ARMs' incidence starts substantially higher than that of FRMs, but the latter seem to catch up over time, as the confidence intervals are overlapping. This second pattern suggests that the 2007 reform accelerated borrowers' prepayments by reducing prepayment penalties on outstanding mortgages: since penalties were concentrated on FRMs, the reform had a larger effect on the prepayments of FRMs than on those of ARMs. Third, the reform did not seem to affect delinquencies and, indeed, the bottom panel shows that we do not observe any effect on the difference between FRMs' and ARMs' cumulative delinquencies. Finally, the slopes of the cumulative incidence functions indicate that the instantaneous hazards of prepayment and delinquency are highest at the beginning of the repayment period, when the loan balance is highest, and then they gradually decline as borrowers have repaid part of the loan, and, thus, the balance is lower.

We further investigate these issues using a semi-parametric Cox model with competing risks, allowing us to analyze how mortgage characteristics are correlated with borrowers' behavior. The Cox model implies that the instantaneous probability of an event k at s , given that borrower i has not fully repaid the mortgage and has not defaulted before s , equals:

$$h_k(s|X_{it}) = h_{0k}(s) \exp(\beta_k X_{it}), \quad (1)$$

where X_{it} are characteristics of the mortgage of borrower i at time t ; β_k are coefficients specific to event k ; and $h_{0k}(s)$ is the baseline hazard of event k . Thus, $h(s|X_{it}) = \sum_{k=1}^K h_k(s|X_{it})$ gives the overall hazard rate, given the K possible events. We include in X_{it} time-invariant mortgage characteristics determined at origination, such as the amount, the loan-to-value, the maturity, and the interest-rate type (i.e., ARM versus FRM); and time-varying mortgage characteristics, such as the interest rate and, most notably, the prepayment penalty, which changed over time because of the 2007 reform.

Table 3 reports hazard rate estimates of different specifications. Specification (1) uses a difference-in-difference-style of comparison, between the differences of the hazards of FRMs and ARMs before and after the reform. The estimates of this specification imply that bor-

Table 3: The Effect of Penalties on Borrowers' Behavior

	PREPAYMENT			DELINQUENCY		
	(1)	(2)	(3)	(1)	(2)	(3)
FRM	0.461*** (0.049)	0.743*** (0.051)	0.631*** (0.073)	0.207*** (0.123)	0.293*** (0.057)	0.333*** (0.113)
POST-REFORM	1.535*** (0.111)			1.834*** (0.387)		
FRM × POST-REFORM	1.013 (0.115)			1.624 (0.993)		
ACTUAL PENALTY		0.730*** (0.026)	0.812*** (0.056)		1.025 (0.088)	0.953 (0.172)
RESIDUAL PENALTY			0.925* (0.041)			1.048 (0.105)
INTEREST RATE	1.592*** (0.030)	1.649*** (0.031)	1.642*** (0.031)	1.640*** (0.093)	1.719*** (0.096)	1.718*** (0.096)
LOG(AMOUNT)	1.095*** (0.033)	1.070** (0.033)	1.081** (0.033)	0.886 (0.067)	0.891 (0.068)	0.887 (0.068)
LOAN-TO-VALUE	0.995*** (0.001)	0.996*** (0.001)	0.996*** (0.001)	1.013*** (0.002)	1.013*** (0.002)	1.013*** (0.002)
MATURITY	1.092*** (0.005)	1.106*** (0.004)	1.107*** (0.004)	1.228*** (0.014)	1.248*** (0.012)	1.248*** (0.012)
ARM REFI RATE	0.971 (0.030)	0.961 (0.029)	0.968 (0.030)	0.662*** (0.053)	0.658*** (0.054)	0.659*** (0.054)
FRM REFI RATE	0.760*** (0.047)	0.773*** (0.048)	0.769*** (0.048)	1.367** (0.181)	1.339** (0.177)	1.341** (0.177)
GDP GROWTH	0.985 (0.009)	0.981** (0.009)	0.979** (0.009)	0.974 (0.021)	0.961* (0.020)	0.962* (0.020)
OBSERVATIONS	1,612,818	1,612,818	1,612,818	1,793,339	1,793,339	1,793,339
MORTGAGES	20,434	20,434	20,434	20,434	20,434	20,434

Notes: The table reports hazard rate estimates using all mortgages issued in 2005. FRM is a dummy variable taking value one when the mortgage has a fixed rate. POST-REFORM is a dummy variable taking the value one after April 2007. ACTUAL PENALTY is the penalty that the borrower pays if he prepays the mortgage. Robust standard error in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

rowers are significantly less likely to prepay and to default on FRMs than on ARMs before the reform. The magnitudes of both differences are large: FRMs' prepayment hazard is approximately 50-percent lower than ARMs', and FRMs' delinquency hazard is approximately 80-percent lower than ARMs'. The reform coincides with a large increase in prepayments on both types of mortgages. Delinquencies also increased after the reform, presumably as aggregate economic conditions worsened (in addition to what contemporaneous GDP growth already captures). The point estimates suggest that FRMs experienced a larger increase in prepayments and delinquencies than ARMs after the reform; however the standard errors around these estimates are quite large, and, thus, the hazard rates are statistically indistinguishable from one.

While we focus primarily on penalties and their revision due to the reform, the effects of mortgage terms are also of interest. Borrowers are more likely to fully prepay mortgages with higher interest rates, of larger amounts, with lower LTVs, and with longer maturities. These results are, perhaps, expected, as the benefits to prepaying mortgages are greater when they have higher interest rates, larger amounts and longer maturities. Moreover, borrowers are more likely to default on mortgages with higher interest rates, of smaller amounts, with higher LTVs, and with longer maturities. Again, these results are largely expected: for example, distressed borrowers may find it more difficult to make payments on more expensive mortgages, and/or a higher interest rates reflect risk-based pricing. Similarly, less creditworthy borrowers are more likely to select mortgages with higher LTVs and longer maturities. Overall, these correlations suggest that borrowers that the lender assessed as risky (as their higher interest rates show) were more likely to prepay and default on their mortgages, perhaps hinting that these risky individuals have not only a higher probability of a negative shock leading to default, such as an income shock, but also a more-general higher probability of shocks, perhaps including positive shocks, as well ¹³ Moreover, the ARM and FRM refinancing rates suggest that borrowers are less likely to prepay and refinance when current interest rate are higher, and particularly so when the FRM refinancing rate increases.

¹³Unfortunately, as we argued in Section 4 when we introduced our data, they do not allow us to provide direct evidence on borrowers' income volatility, but our analyses uncover several patterns consistent with this interpretation.

The correlations between the refinancing rates and the default hazard rates are, perhaps, more difficult to interpret, but they indicate that delinquencies increased when refinancing rates on ARMs and FRMs diverged after 2011.

Specification (2) seeks to understand the relationships between penalties and the prepayment and the delinquency hazard rates by including the time-varying actual penalties among the covariates. Thus, for each mortgage in the sample with a positive penalty at origination, the penalty takes on two different values: the contractual penalty before April 2007 and the revised lower penalty after April 2007; for mortgages with no penalties at origination, the penalty always equals zero. The estimates indicate that the prepayment hazard is 27-percent lower for mortgages that feature a one-percentage-point larger penalty—i.e., a large magnitude. Moreover, the delinquency hazard is approximately 2.5-percent higher for mortgages that feature a one-percentage-point larger penalty, although the estimates of this magnitude are not precise and, thus, we cannot reject the hypothesis that penalties have no effect on delinquencies. The effects of other mortgage terms are quite similar to those of specification (1).

While most of the variation that specification (2) exploits is by comparing penalties before and after the 2007 reform, the estimated relationship between penalties and the hazard rates in specification (2) lumps together two effects: 1) penalties directly affect borrowers' cost-benefit analysis when deciding to prepay or default; and 2) at the time of contracting, borrowers who expect that they are less likely to prepay or to default on their mortgage could select higher-penalty mortgages, with perhaps other more-favorable terms.

Specification (3) seeks to decompose these two different effects using a two-step control function (Blundell and Powell, 2003), following a similar approach to that of Adams, Einav, and Levin's (2009) analysis of delinquencies on subprime car loans. More specifically, in the first step, we regress the time-varying penalty on mortgage characteristics, as well as on an indicator variable that equals one after April 2007, and zero otherwise, and its interaction with an indicator variable that equals one for FRMs, and zero for ARMs. We then construct the residuals of this regression. By construction, the residuals capture the variation in penalties at the time of contracting, thus containing borrowers' (private) information or

preferences as pertains to their choice of penalties. In the second step, we include both the time-varying penalties and the residuals in the estimation of the hazard rates. By including the residual penalty when estimating the prepayment and delinquency hazards, as well as the other observed covariates, the remaining variation in actual penalties is due entirely to the reform. Hence, the two-step control function applies the insights and the identification of an instrumental variable approach to a non-linear hazard model, using the indicator variable that equals one after April 2007, along with its interaction with the indicator variable that equals one for FRMs, as the excluded first-stage instruments.

The estimates of specification (3) indicate that an exogenous one-percentage-point increase in the penalty decreases the prepayment hazard by approximately 20 percent, thus providing evidence of a large direct effect of penalties on prepayment. Moreover, the estimates of the hazard rates associated with the residuals suggest that borrowers who selected mortgages with one-percentage-point larger penalties have a 7.5-percent-lower prepayment hazard, thereby providing evidence of the selection of borrowers at the time of contracting; however, the estimate of this selection effect is quite noisy and only marginally significant.

Furthermore, an exogenous one-percentage-point increase in the penalty decreases the delinquency hazard rate by approximately five percent, although the estimate is not statistically different from zero. This estimate indicates that the delinquency rate observed after the reform in specification (1) is not due to the reduction in penalties, but, rather, to the worsening of aggregate economic conditions. Similarly, the hazard rate associated with the residual of the first step indicates that mortgages with larger penalties are more likely to default, although, again, the standard errors do not rule out that this hazard rate is indistinguishable from one. Overall, the delinquency hazard estimates are imprecise, and, thus, we have no statistically-significant evidence that prepayment penalties have a direct effect on default behavior, in contrast to the U.S. evidence reported in Rose (2013); perhaps, the fact that mortgages are recourse loans under Italian law, while they are non-recourse loans in several U.S. states, could explain these different patterns of defaults. Moreover, the evidence that borrowers with (private) information about their default risk at the time of contracting select higher-penalty mortgages is weak in this sample.

Table 4: Differences between FRMs and ARMs by year of issuance

	FRM		DIFFERENCE	ARM		DIFFERENCE
	2005	2009		2005	2009	
SHARE (%)	29.00	60.00	-31.00***	71.00	40.00	31.00***
INTEREST RATE (%)	4.87	5.05	-0.18**	3.52	2.17	1.35***
AMOUNT (000 EUROS)	78.78	101.00	-22.23***	113.12	139.41	-26.29***
COLLATERAL (000 EUROS)	203.60	213.90	-10.30*	229.58	295.67	-66.09***
LOAN-TO-VALUE (%)	47.65	53.51	-5.87***	59.09	57.64	1.46***
MATURITY (YEARS)	16.66	19.55	- 2.88***	20.38	21.25	-0.87***
PENALTY AMOUNT (%)	2.60	0.00	2.60***	0.40	0.00	0.40***
DELINQUENCY (%)	3.00	1.00	2.00***	5.00	1.00	4.00***
DELINQUENCY - 4 YEARS (%)	0.00	1.00	-1.00***	1.00	1.00	0.00***
PREPAYMENT (%)	21.00	12.00	0.09***	27.00	8.00	19.00***
PREPAYMENT - 4 YEARS (%)	6.00	12.00	-0.06***	16.00	8.00	8.00***

Notes: DELINQUENCIES - 4 YEARS and PREPAYMENT - 4 YEARS are the respective variable when the event is realized within four years from issuance. t statistics in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

5.3 Prepayment Penalties and Borrowers' Mortgage Choice

In this section, we compare mortgages issued in 2009 to those issued in 2005 to analyze the effect of prepayment penalties on borrowers' choice between FRMs and ARMs. Specifically, we proceed by leveraging one key advantage of our data and, thus, we perform a within-period comparison of the ex-post performance of mortgages issued in different years. We acknowledge at the outset that the results on the direct effect of penalties on prepayments and delinquencies that we reported in Section 5.2 rely on a stronger identification than those that we report in this section. Nonetheless, we believe that the patterns that we report in this Section are suggestive of a change in borrowers' mortgage selection after the 2007 reform, as our different within-period analyses seek to reduce the concerns that aggregate shocks between 2005 and 2009—i.e., our lender merged with another bank in 2007, and the financial crisis and the European sovereign-debt crisis affected credit markets from 2008—are confounding the interpretation of across-time comparisons.

Table 4 presents simple univariate comparisons between FRMs and ARMs issued in 2005 and 2009, displaying some interesting patterns. First, the share of FRMs doubled, as Felici, Manzoli, and Pico (2012) also report for the aggregate Italian market. Second, this increase is particularly striking because, simultaneously, interest rates on FRMs increased and interest rates on ARMs decreased. The two patterns together suggest that a change in other mortgage characteristics has made FRMs more attractive over time—the change in penalties could be one of them—and to riskier borrowers, in particular. Third, LTVs of FRMs increased, whereas LTVs of ARMs decreased. Finally, maturity of FRMs increased relatively more than that of ARMs. These observable mortgage characteristics further reinforce the idea that the ex-ante riskiness of FRMs increased relative to that of ARMs between 2005 and 2009. Indeed, ex-post performances seem to confirm this increase in riskiness: delinquencies on FRMs increased relatively more than on ARMs; and prepayments of FRMs increased, whereas prepayment of ARMs declined over time. These patterns seem consistent with our earlier interpretation that riskier borrowers face greater overall uncertainty and, thus, are more likely to suffer both shocks leading to prepayments and shocks leading to delinquencies.

Figure 2 plots the non-parametric cumulative incidence functions for mortgages issued in 2009, displaying a stark contrast with those of Figure 1: cumulative prepayments of FRMs are statistically significantly higher than ARMs' for mortgages issued in 2009, whereas they were lower for those issued in 2005; cumulative delinquencies of FRMs start statistically significantly higher than ARMs' for mortgages issued in 2009 (although they then become statistically indistinguishable), whereas they started lower for those issued in 2005.

Table 5 reports hazard rate estimates of different specifications of the semi-parametric Cox model with competing risks, using mortgages issued in 2005 and in 2009. Specification (1) uses a difference-in-difference-style comparison, comparing the differences between the hazards of FRMs and ARMs before and after the reform. This is similar to the comparison that we reported in specification (1) of Table 3, with the difference that the after-reform comparison group now also includes all mortgages issued in 2009. Indeed, the estimates of the prepayment hazard rate is larger in magnitude than that of specification (1) in Table 3,

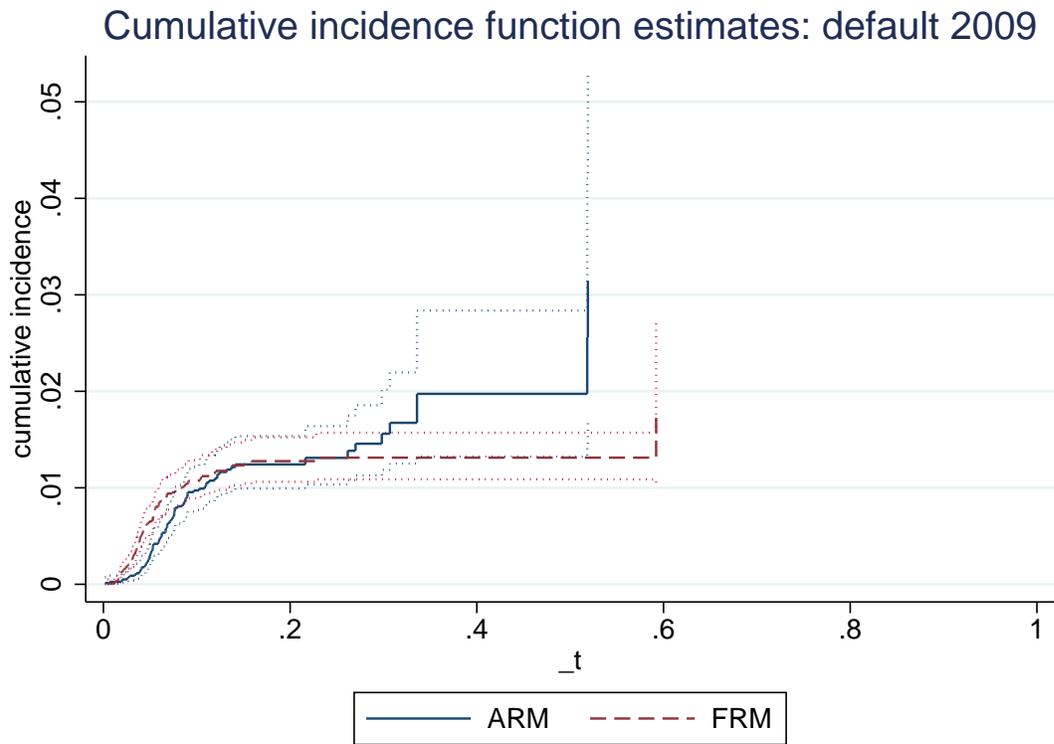
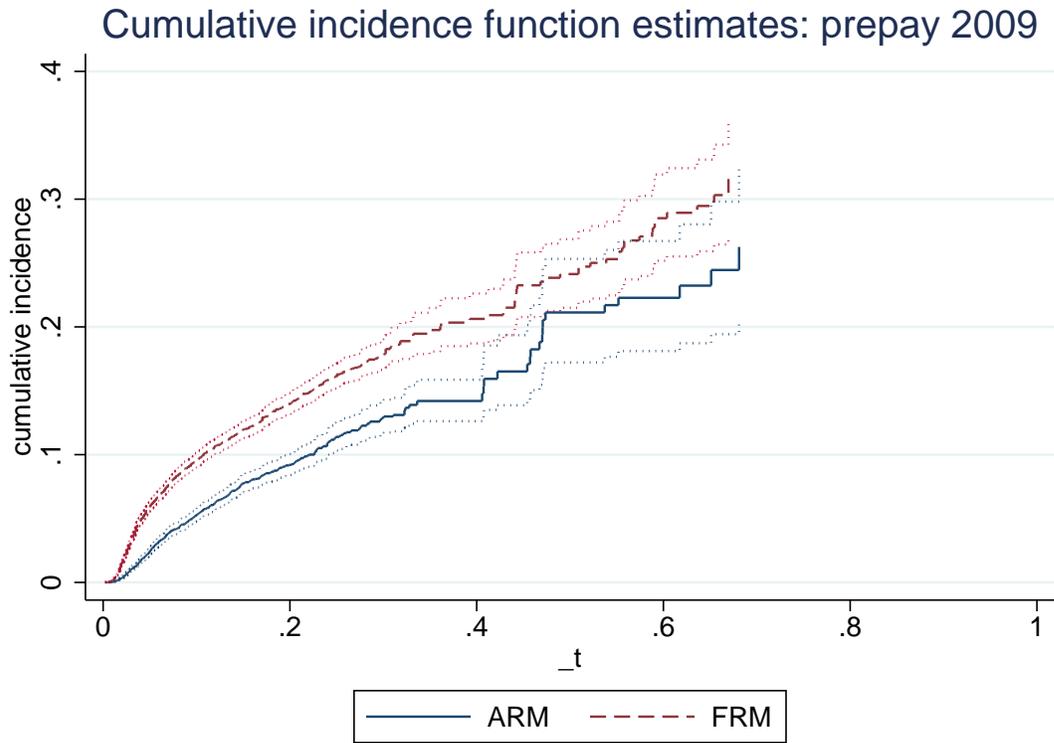


Figure 2: The top panel displays the cumulative incidence of prepayments; the bottom panel displays the cumulative incidence of delinquencies of mortgages issued in 2009.

suggesting that the 2009 cohort repaid mortgages at a higher rate than the 2005 cohort after the reform. Similarly, the comparison of the estimates of the delinquency hazard between specifications (1) of Tables 3 and 5 indicate that the 2005 cohort defaulted at a higher rate than the 2009 cohort.

Specification (2) uses another difference-in-difference-style comparison, comparing the difference between the hazards of FRMs and ARMs issued before and after the reform. Hence, specification (2) compares the performances of mortgages issued in 2005 with those issued in 2009 from their respective origination, whereas specification (1) compares performances of mortgages issued in 2005, from their origination until the 2007 reform, to the performances of both mortgages issued in 2005, starting from the 2007 reform until December 2012, and mortgages issued in 2009, from their origination until December 2012. The estimates of the prepayment hazard rates confirm that borrowers are significantly less likely to prepay FRMs than ARMs issued before the reform. The magnitude of this effect is also almost identical to the one that we reported in specification (1) of Table 3, using only mortgages issued in 2005 and comparing them before and after the reform reduced the penalties. The estimate of the hazard rate associated with FRM issued in 2009 indicates that prepayments on FRMs have increased more over time than those on ARMs have. The magnitude of this effect is sizable: the estimate implies that the difference in the prepayment hazard between FRMs and ARMs has increased by 35 percent between mortgages issued in 2005 and in 2009.

The estimates of the delinquency hazard rates show that borrowers are significantly less likely to default on ARMs issued in 2009 than on ARMs issued in 2005, whereas borrowers are relatively more likely to default on FRMs issued in 2009 than on FRMs issued in 2005. The magnitudes of these differences are large: borrowers are 15-percent less likely to default on an ARM issued in 2009 than on an ARM with similar characteristics issued in 2005. However, the sum of the estimates of the hazard rates associated with ISSUED IN 2009 and $\text{FRM} \times \text{ISSUED IN 2009}$ indicates that borrowers are more likely to default on FRMs issued in 2009 than on those issued in 2005, by approximately 45 percent. Therefore, the differences in delinquencies between FRMs and ARMs have increased over time, by approximately 60 percent—a large amount. These patterns suggest that borrowers' mortgage choice between

Table 5: The Effect of Penalties on Borrowers' Mortgage Choice

	PREPAYMENT			DELINQUENCY		
	(1)	(2)	(3)	(1)	(2)	(3)
FRM	0.465*** (0.049)	0.430*** (0.019)	0.477*** (0.050)	0.188*** (0.112)	0.255*** (0.039)	0.189*** (0.113)
POST-REFORM	1.824*** (0.098)		1.572*** (0.094)	1.406** (0.228)		1.484** (0.264)
ISSUED IN 2009		1.332*** (0.069)	1.118** (0.063)		0.847 (0.109)	0.748** (0.103)
FRM × POST-REFORM	1.101 (0.122)		0.924 (0.105)	1.548 (0.937)		1.471 (0.899)
FRM × ISSUED IN 2009		1.351*** (0.085)	1.365*** (0.087)		1.591*** (0.260)	1.549*** (0.254)
INTEREST RATE	1.648*** (0.027)	1.706*** (0.030)	1.655*** (0.030)	1.834*** (0.088)	1.839*** (0.096)	1.768*** (0.096)
LOG(AMOUNT)	1.134*** (0.029)	1.121*** (0.029)	1.117*** (0.029)	0.933 (0.063)	0.939 (0.063)	0.935 (0.063)
LOAN-TO-VALUE	0.995*** (0.001)	0.995*** (0.001)	0.995*** (0.001)	1.011*** (0.002)	1.011*** (0.002)	1.011*** (0.002)
MATURITY	1.091*** (0.003)	1.115*** (0.003)	1.103*** (0.004)	1.223*** (0.010)	1.232*** (0.010)	1.221*** (0.011)
ARM REFI RATE	1.001 (0.025)	1.039 (0.027)	1.038 (0.027)	0.620*** (0.045)	0.625*** (0.046)	0.633*** (0.046)
FRM REFI RATE	0.607*** (0.029)	0.571*** (0.027)	0.591*** (0.028)	1.351*** (0.148)	1.285** (0.141)	1.332*** (0.148)
GDP GROWTH	0.981** (0.008)	0.969*** (0.008)	0.980** (0.008)	0.976 (0.019)	0.967* (0.018)	0.977 (0.019)
OBSERVATIONS	2,371,091	2,371,091	2,371,091	2,585,401	2,585,401	2,585,401
MORTGAGES	40,025	40,025	40,025	40,025	40,025	40,025

Notes: The table reports hazard rate estimates using all mortgages issued in 2005 and in 2009. FRM is a dummy variable taking value one when the mortgage has a fixed rate. POST-REFORM is a dummy variable taking the value one after April 2007. ISSUED IN 2009 is a dummy variable taking the value one if the mortgage is issued in 2009. Robust standard error in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

FRMs and ARMs at the time of contracting, along with their prepayment and delinquency behavior throughout the amortization period, changed substantially between 2005 and 2009, and relatively more so for riskier borrowers. Since Table 2 documents that mortgages offered to these more-risky borrowers were more likely to include penalties, these patterns of delinquencies are consistent with the idea that reform—and, thus, penalties—had a larger effect on the mortgage selection of riskier borrowers than on that of less-risky ones.

The effects of other mortgage terms are identical in signs and very similar in magnitudes to those reported in Table 3, suggesting that the reform had quite an important effect on borrowers' choice of FRMs versus ARMs, but not on other terms.

Specification (3) seeks to combine the comparisons of specifications (1) and (2), thereby performing a finer comparison than each of them individually. More precisely, specification (3) compares mortgages issued in 2009, from origination, to those issued in 2005, from the 2007 reform that reduced penalties on them. While we acknowledge that, had the reform completely abolished penalties on outstanding mortgages, it would have allowed an even cleaner comparison, we believe that specification (3) is as close as we can get to this ideal comparison.

This finer comparison delivers several results. First, the estimate of the prepayment hazard rate for the variable POST-REFORM confirms that borrowers are more likely to prepay their mortgages after the reform reduced/abolished penalties. Second, the estimate of the prepayment hazard rate for the variable ISSUED IN 2009 means that, once we account for the reduction in penalties, borrowers are prepaying mortgages issued in 2009 at a higher rate than for those issued in 2005. Third, the point estimate for $FRM \times POST\ REFORM$ suggests that, after the reform, FRMs' prepayment hazard is statistically indistinguishable from that of ARMs. Finally, the point estimate for $FRM \times ISSUED\ IN\ 2009$ indicates that the difference in prepayment hazard rates between FRMs and ARMs has increased by 36 percent when we compare mortgages issued in 2009 with those issued in 2005, but after the reform reduced penalties on them. Overall, the estimates of these two interactions suggest that the selection of borrowers at the time of contracting mainly accounts for the differential increase in prepayments between the cohorts of FRMs and ARMs, as the difference in prepayments

between FRMs and ARMs after the 2007 reform arises exclusively for mortgages issued in 2009.

The estimates of the delinquency hazards of specification (3) show that borrowers are more likely to default on their mortgages after 2007. As we reported in Section 5.2, this is likely not due to the reform per se, but, rather, to the worsening of aggregate economic conditions. Moreover, the estimate for the variable ISSUED IN 2009 means that borrowers' delinquencies on mortgages issued in 2009 is 25-percent lower than on mortgages issued in 2005. The point estimate for $\text{FRM} \times \text{POST REFORM}$ suggests that, after the reform, the FRMs' delinquency hazard is higher than ARMs', although the standard errors are large and, thus, we have no statistically-significant evidence that the hazard rates differ. The point estimate for $\text{FRM} \times \text{ISSUED IN 2009}$ indicates that the difference in delinquency hazard rates between FRMs and ARMs has increased by approximately 55 percent when we compare mortgages issued in 2009 with mortgages issued in 2005, but after the reform. Overall, these delinquency rates seem to describe a consistent pattern that prepayment penalties have no direct effect on borrowers' delinquencies, as we already documented in Table 3. Instead, they buttress the conclusion that borrowers' selection of FRMs versus ARMs is substantially different after the reform, most notably for riskier borrowers, who were more likely to be affected by the reform because their mortgages were more likely to include higher penalties before the reform (see Table 2).

6 Conclusions

We provide evidence from a 2007 reform in Italy that reduced prepayment penalties on outstanding mortgages and eliminated them on newly-issued ones. Our findings show that prepayment penalties have a direct effect on borrowers' prepayment behavior, whereas they suggest that prepayment penalties do not have a direct effect on borrowers' delinquencies. Moreover, we find suggestive evidence that prepayment penalties have an indirect effect on prepayments and delinquencies through borrowers' selection of mortgage type at the time of contracting, and particularly so for borrowers who face greater uncertainty.

Overall, the magnitudes of all these effects are sizable, implying that prepayment penalties have quite a large effect on borrowers' behaviors and borrowers' choices. While we study the effect of a reform in one country (Italy) using data from one lender, the choice of a mortgage is one of households' most important financial decisions and its management has important aggregate implications. Hence, we believe that our empirical results should be useful for the design and regulation of mortgage markets more broadly.

More generally, our results have implications for the aggregate consequences of reducing prepayment costs. On the one hand, lower prepayment costs imply that households can more easily adapt to changes in interest rates. On the other hand, lenders and mortgage investors face bigger prepayment risk, and hedging this risk has potential implications for the level and the volatility of interest rates, as well as for risk premia. These extra financial burdens on lenders imply that households may pay higher costs for the increased flexibility that lower prepayments allow them. A complete evaluation of all these different links would require a general equilibrium model that is outside of the scope of this paper, as it is not a priori clear whether the welfare gains for consumers compensate for the extra costs imposed on financial investors.

Appendix: International Comparisons

Table 6 presents a comparison of the current regulations of prepayment penalties in selected countries. Italy outlawed penalties on all mortgages, and the U.S. outlawed them on ARMs and high-priced FRMs. Most other countries impose a cap on penalties that usually differs between FRMs and ARMs.

Table 6: Regulation of Prepayment Penalties, Selected Countries

COUNTRY	PREPAYMENT COSTS
Italy	No penalties
Germany	Interest margin damage and reinvestment loss on fixed rate
France	Maximum 6 months interest or 3% of outstanding balance
Spain	Penalties up to 2.5% on fixed rate; 0.5% on variable rate
Denmark	Yield maintenance on short-term fixed with non-callable bond
U.K.	Penalties equal to 2-5% of amount repaid
U.S.	No penalties on ARMs, high-priced FRMs and three years after origination.

Sources: Authors' elaboration from Campbell (2013) and IMF (2011).

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